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STATE OF MINNESOTA

Office Memorandum

DEPARTMENT Health

TO : Melanie Toepfer 5E-WHME
U.S. Environmental Protection Agency
Water & Hazardous Materials Enforcement
230 S. Dearborn St.
Chicago, Illinois 60604

DATE: 3/18/81

FROM : Mike Convery

PHONE: 612-296-5297

US EPA RECORDS CENTER REGION 5
515326

SUBJECT: Hickok Report: Alternatives for Contaminated Soil Management

I am forwarding to you for your ~~review~~ information and review a copy of Hickok's second work report! Any comments you have would be appreciated

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545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224

March 13, 1981

Mr. Michael Convery
Division of Environmental Health
Minnesota Department of Health
717 Delaware Street SE
Minneapolis, Minnesota 55440

Re: St. Louis Park Groundwater Contamination Study -
Alternatives for Contaminated Soil Management

Dear Mr. Convery:

Enclosed is a memorandum (G18-2) on contaminated soils management alternatives, fulfilling Task 5010 of the referenced project. This letter also notes the delivery to your office on March 2, 1981, of a data review and evaluation (memorandum G18-1) for the same project.

Let me know if you have any questions on the enclosed.

Respectfully submitted,

EUGENE A. HICKOK AND ASSOCIATES

John B. Erdmann, P.E.

JBE/bt

Enclosure

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G18-2

MARCH 12, 1981

ST. LOUIS PARK GROUNDWATER CONTAMINATION STUDY -
ALTERNATIVES FOR CONTAMINATED SOIL MANAGEMENT

THIS MEMORANDUM EXAMINES ALTERNATIVE METHODS FOR THE MANAGEMENT OF CONTAMINATED SOILS STEMMING FROM FORMER COAL TAR OPERATIONS AT ST. LOUIS PARK, MINNESOTA. ALTERNATIVES ARE CONSIDERED UNDER THE CATEGORIES: ON-SITE, OFF-SITE, AND ELECTIVE LOCATION. THIS MEMORANDUM REPRESENTS COMPLETION OF TASK 5010 OF THE REFERENCED PROJECT. A FUTURE MEMORANDUM WILL ANALYZE ENVIRONMENTAL AND ECONOMIC IMPACTS OF THE CONTAMINATED SOIL MANAGEMENT METHODS.

ALTERNATIVES FOR CONTAMINATED SOIL MANAGEMENT

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1. INTRODUCTION

The purpose of this memorandum is to examine alternative methods for the management of contaminated soils stemming from former coal tar operations at St. Louis Park, Minnesota. The following is a description of the contaminants and of alternatives for management of the contaminated soil.

A. Coal Tar Distillates

The refining of coal results in four major derivatives. These are gas, gas liquor, tar and coke. The tar can be further processed into the distillates known as light oil, middle oil, heavy oil, refined tar and pitch. The predominant products of these coal tar distillates are grades of creosote and road tar.

Coal tar distillates have been used for many purposes. Some of the uses include solvents, dye stuffs, varnish, explosives, food preservatives, paint thinner, insecticides, plastics, aspirin, flavorings, lubrication greases, paints, shingles, roofing, waterproofing and electrocarbons.(11) Recently, however, petroleum distillates have replaced coal tar distillates for many of these uses.

A U.S. Department of Energy report(14) states: "The environmental and health hazards posed by the many coal tar compounds are uncertain. The chemical structure of many species appears to indicate a potential carcinogenic risk which is higher than that of conventional petroleum products. The potential for adverse health effects resulting from contact with coal-derived liquid fuels and from exposures to trace levels [of coal-derived products] resulting from plant emissions are areas of concern." Of special concern are the compounds known as polynuclear aromatic hydrocarbons (PAH), some species of which have a pronounced tendency to be carcinogenic.[5]

B. Soil Contamination at St. Louis Park

The Republic Creosote Company, a subsidiary of Reilley Tar and Chemical Company, operated a facility on an 80-acre site in St. Louis Park from 1917 to 1972.[12] The company operation consisted of coal carbonization and coal tar distillation in order to produce heating coke, road tar and creosote. The creosote was used on-site as a preservative to impregnate wood products.[12]

In early production years, the coal carbonization resulted in the production of a residue called coke and vapors which, when condensed and separated, produced coal tar chemicals, referred to as tar, light oil, ammonia liquor and coke oven gas. These crude fractions were further refined to produce the desired finished products, road tar and creosote. In later years, coal carbonization was discontinued but distillation of coal tar as a secondary refining operation was continued.[12]

A 1976 report on soil contamination at the Republic site[12] observes: "Over the years of operation, creosote and coal tar were spilled or disposed of on the ground. These materials are now moving through the soils." In some parts of the site, hydrocarbons have been reported to be present in the soil at depths of approximately 60 feet.[1] The soils at the site consist of fill, glacial sands, glacial till, peat and muck.[1]

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In the following sections of this memorandum, several processing, storage and disposal alternatives for management of the hydrocarbon-contaminated soils are reviewed. A brief description of each alternative is provided.

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II. ON-SITE ALTERNATIVES

On-site alternatives include no action and capping. These methods do not require excavation of the material and result in minimal disturbance of the present landscape.

A. No Action

One option is to do nothing and leave the soils in-place. The existing contaminated soils that are the principal source of groundwater contamination remain in-place. With extended time, dilution will take place and the impact of the source material will be lessened. The option does not present any significant immediate environmental advantages and will result in continuous long-term adverse effects on the groundwater resource.

B. Capping

This action leaves the contaminated soil material in-place. The immediate area of the contamination would be capped or covered with compacted clay, concrete, asphalt or other impermeable cover.

The cap serves to minimize infiltration by precipitation. The site under this option should also be contoured to minimize surface runoff impacts and further reduce opportunities for infiltration. The contaminated soil is generally saturated with groundwater and this dynamic condition would continue after capping had been accomplished.

A major limitation of this alternative is that the source is still in-place. This action requires perpetual maintenance of the cap or cover to assure that its integrity is maintained and that it remain impermeable. Minimal and undetermined environmental impact mitigation is expected from this alternative if this is the only remedial method utilized.

III. OFF-SITE ALTERNATIVES

It should be understood that off-site alternatives imply excavation of the contaminated material and transportation to some other suitable location. The excavation area and its resultant surface water pond and changed groundwater flow conditions are a matter of consideration for all off-site alternatives and will be discussed in a subsequent report. The presented off-site alternatives are landfilling, landspreading, resource recovery, warehousing and storage in concrete vault.

A. Landfill

A landfill is one possible method of disposal of the contaminated soils from the St. Louis Park site. Landfilling is the predominant technique of waste disposal in use today.(2)

Landfilling of hazardous wastes is used mainly for nonincinerable wastes which are not suitable for recovery.(2) Landfilling has the advantage of potential later recovery of materials since the wastes are in a confined, known and controlled location. A large land area would be required for landfill disposal of the large volume of materials from the St. Louis Park site.

Even the best situated landfill may have a potential for polluting ground and surface waters. For that reason, a hazardous waste landfill containing contaminated soil from the site would require on-going expenditure for monitoring and maintenance.

1. Non-Containerized Landfilling

Non-containerized landfilling entails placing the hazardous waste in an unconsolidated form, which requires a secured facility.

A secured landfill is an ultimate disposal site specifically designed to contain hazardous wastes and minimize environmental contamination.[13] A secured landfill implies that surface water diversion actions have been taken as well as possible capping, liners and/or leachate collection systems. A properly designed facility also includes equipment for groundwater and surface water monitoring and evaluation.

2. Encapsulated/Containerized Storage

Encapsulation is a physical process in which an agent surrounds the waste particles.[13] These agents may include chemical compounds as well as physical confinement methods such as barrels or other containers suitable for long-term storage. These containers may then be covered or enclosed by concrete and/or buried.[6]

Encapsulation of hazardous wastes involves securing the wastes in a solid form. In this manner, the surface area of the waste is reduced and the low permeability of the resultant solid prevents rapid leaching of the toxic contaminants.[2] Encapsulated wastes are considered not necessarily to need placement in a secured landfill.[13] This alternative requires that additional time and capital be expended to containerize the material before landfilling.

B. Landspreading

Municipal and some industrial sludges and wastes are often disposed of by landspreading. As stated by Brunner et al[4]: "When compared with other methods, disposal to the land is often the least expensive, although not necessarily the most environmentally sound method of disposing of hazardous wastes." 00118

A March 1980 research paper[3] on land cultivation for waste disposal states: "Landspreading, also called landfarming, land treatment, and soil incorporation, is the controlled disposal of wastes in the surface soil accompanied by the continued monitoring and management of the disposal site. Although this means of disposal has been used by the petroleum industry to dispose of process sludges, information is still needed on site selection, optimum soil and climatic conditions, application rates and scheduling, decomposition products, potential contaminant emissions and the persistence of toxic residues."

Degradation of oily petroleum sludges by microbial action in cultivated soil has been demonstrated at prevailing soil and climatic conditions at Deer Park, Texas.[9] Simultaneous experiments were conducted with three oils, i.e., crude oil, Bunker C fuel oil and waxy raffinate oil (an intermediate waxy oil product containing high paraffinic components).

For crude oil and Bunker C fuel oil, both aromatic and saturated petroleum hydrocarbons decreased in the soil with time, but for waxy raffinate oil, only the saturated fraction appeared to be reduced.[9] Under the conditions of the test, neither oil nor fertilizers infiltrated vertically in the soil.[9]

Residual oil extracted from the soil was characterized by infrared scan to be polyaromatic oils, suggesting this hydrocarbon group to be slowly reactive or nonreactive for microbial decomposition at

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the prevailing conditions.[9] These results suggest that the polynuclear aromatic hydrocarbons of concern at St. Louis Park may also be slowly reactive or nonreactive to landspreading.

C. Resource Recovery

1. As-Is

One method of disposing of the contaminated soil is to use the material as a resource. The most cost effective method is to use the material as it is. One option would be to excavate the sandy soil and use it as road material. The peat and glacial till material would have to be handled and disposed of by some other method.

It has been suggested[8] that the contaminated sands be used as a subgrade material upon which a modern asphaltic road could be placed. Modern asphaltic roads are now made with petroleum-based compounds. However, coal tar distillates are generally considered to be incompatible with petroleum distillates. With this understanding of the incompatibility, it would not be advisable to mix screened sandy coal tar hydrocarbon-laden materials with petroleum-derived asphalt mix to arrive at an asphaltic batch mix.

The presence of coal tar contaminants in properly screened subgrade material should not preclude use as a sub-base medium. If suitable studies of this procedure proved the method as being engineering and environmentally feasible, the material could then be used in sub-base material beneath asphalt or other roads. The material would have to be well drained before placement and used in unsaturated conditions.

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The sandy material may also be used as-is on low priority roads such as farm roads and secondary county roads.[8] It is reasoned that the contaminants would adhere to the sand grains with minimal leaching. In the event that leaching does occur, it could be reasoned that the material will be spread out over a large area so as to mitigate environmental impacts. This method needs further study to determine its appropriateness. An advantage of this method is the use of the material.

2. Modified

Methods of possible hydrocarbon recovery require a modification of the material and include hydrogenation, pyrolysis, flash photolysis, arc image heating, reaction with plasma, laser irradiation and very rapid pyrolysis. A study of a microwave discharge has also been undertaken.(14) These methods are considered relatively experimental for this application and are offered for completeness of this memorandum only.

D. Warehousing

Warehousing is a form of engineered storage, the ultimate goal of which is either reclamation or later permanent disposal of the toxic substance. Engineered storage must provide both safe long-term storage and retrievability of any of the substances at any time. In itself, it is not a method of ultimate disposal.

The prospect for eventual reclamation of the stored material would be dependent upon finding a compatible use for the contaminated soil material as it is and/or determining that the amount of hydrocarbon absorbed in the material is worth salvaging.[6]

E. Concrete Vault

Underground concrete vaults provide another means of engineered storage. It should be assumed that eventual failure of the concrete will occur and that the ultimate disposal method will be a slow release of the contaminants.

A modern engineered landfill disposal facility would seem to be superior to underground concrete vault storage. The alternative of landfill disposal shifts the focus from artificial protection to the natural protective characteristics of the disposal site. The latter are of greatest importance to ultimate disposal of the wastes. Underground concrete vaults as now visualized do not provide an ultimate disposal means for the St. Louis Park contaminated soils.

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IV. ELECTIVE LOCATION ALTERNATIVES

Elective location alternatives are those alternatives that can be performed either on-site or off-site. In some cases special equipment may need to be constructed on-site. A combination of on-site/off-site facilities may be required. The elective location alternatives that will be discussed include solidification, fixation/stabilization, admixing, flushing and incineration.

A. Solidification

Hazardous wastes can be bound in a solid form. In this manner, the surface area of the waste is reduced and the low permeability of the resultant solid prevents rapid leaching of the toxic components.(13) This procedure may be accomplished by injection of chemical agents in-place or by excavation, processing and replacement of the processed soils on-site or off-site.

A wide variety of solidification agents have been used in hazardous waste material. These agents include the following: portland cements, urea-formaldehyde, asphalt, pozzolanic cements, polybutadiene silicates, sulfur foams, soil-binding agents and ion exchange resins.(13) The solidification agents may themselves be considered potential sources of pollution and must be assessed accordingly.

Hazardous wastes that have been properly stabilized and solidified do not need to be placed in a secured landfill. A well designed landfill close to the waste source should be adequate in most cases. This disposal option is allegedly more expensive than secured landfilling, however, there is a point at which transportation costs offset this differential.(13)

To prepare hazardous wastes adequately for disposal outside a secured landfill, the wastes must be analytically characterized for treatment process compatibility, subjected to a stabilization or a pretreatment process and solidified. The steps do not in themselves provide a fail-safe means of handling these wastes, but they do provide a reasoned approach to treating the wastes.(13)

The advantages of this alternative include handling the soil on-site and a significant potential for contaminant mitigation. The disadvantages include substantial expense and the complexities and uncertainties of a process that has not been attempted on a project of this size.

B. <u>Fixation/Stabilization</u>

Fixation of waste material proceeds by mixing one or more additives with the waste to impart different chemical and physical properties. (Most additives used are proprietary and patented.) The primary factor contributing to improvement in leachate quality from fixed wastes is the reduction in raw waste surface area exposed to leaching. Chemical fixation may alter the concentration of a particular contaminant and affect the solubility in a variety of ways, including altering the pH or complexing or sequestering the contaminant in a matrix provided by the additive.(10)

Fixation protects the potential pollutants of the waste from dissolution by rainfall or groundwater. If fixation slows the rate of release of pollutants from the wastes sufficiently so that no serious stresses are exerted on the environment, the wastes have been rendered essentially harmless and restrictions on the disposal site may be minimal. As in solidification, however, sometimes the chemical additives themselves could be a source of a pollutant problem.(10)

If a stabilized and solidified waste is disposed of in a less than secured landfill, such as in-place on-site, assurances must be given that the process will hold up over geological time.(13) One report on chemical fixation of wastes(10) states: "Under long-term exposure and weathering, the fixed waste may crack or deteriorate to a point where significant leaching may occur. It should be recognized that reducing the leaching of pollutants by chemical fixation is process-dependent but appears to be successful for selected industrial wastes."

The bulk of the data base for chemical fixation technology has been developed using inorganic industrial wastes and air treatment residues.(10) A slurry of less than 25 percent solids is the usual medium for treatment. At the St. Louis Park site, this would require that water be mixed with the soils to create the appropriate slurry for treatment. This process would require excavation of the material for treatment and a resultant mass of treated soil that may be four times the volume of the original material.

C. Admixing

Admixing is the process of adding another material or materials and blending it with the parent material. It is known that sand particles do not readily adsorb the hydrocarbon contaminants. The addition of peat may tend to adsorb the hydrocarbons and reduce their overall solubility.

This technique would require excavation of the material, blending and replacement on-site or off-site. An admixture technique at the site may result in an increased bulk of material. No known admixture project of this size has been accomplished.

D. Flushing

This technique would require that the material be excavated and that the hydrocarbon contaminants be flushed or removed from the sand and soil grains. The soil material could then be replaced on site, stored or used elsewhere.

Flushing of the soil materials may be accomplished by steam stripping or by solvent extraction. These techniques would undoubtedly be complex with an unknown positive environmental impact. Although these methods appear to be conceptually sound, they have not been undertaken in a field situation of this magnitude.

E. Incineration

Incineration is recognized as a disposal technique for some hazardous wastes.(2) Under special conditions, many organic hazardous wastes may be incinerated.(13) Organics are composed of carbon and hydrogen, and other elements and can be transformed to their stable oxide forms by incineration.

Incineration of wastes which are not pure liquids such as the soils in this project presents a waste disposal problem. The combustion principles are the same as for liquids but the manner in achieving the combustion is different. Residence time and temperature must be carefully controlled in order to achieve complete combustion. Some of the types of incinerators which are applicable to this type of disposal problem are rotary kilns, multiple hearth furnaces and fluidized bed incinerators.(6)

Incineration could take place on-site in a specially constructed burning apparatus with ash disposal on-site. Off-site incineration is also a possibility. Secondary benefits of incineration may include disposal of garbage and other solids as well as possible generation of steam or power.

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V. SUMMARY

Many of the methods reviewed in this memorandum are considered to have sufficient potential to warrant further investigation. Further study may indicate that a combination of techniques may be most applicable for resolving this situation. Table 1 presents the alternatives that have been presented.

This review of alternative methods for managing contaminated soils at the St. Louis Park site will be followed by detailed environmental and economic impact analyses of the potential practical methods.

TABLE 1

Potential Management Methods

Alternative	On-Site Alternatives	Elective Location Alternatives	Off-Site Alternatives
No Action	X		
Capping	X		
Solidification		X	
Fixation/Stabilization		X	
Admixing		X	
Flushing		X	
Incineration		X	
Landfill			
Non-Containerized			X
Containerized			X
Landspreading			X
Resource Recovery: As-Is			X
Resource Recovery: Modified			X
Warehousing			X
Concrete Vault			X

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